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***On Uncertainty Aversion under Complete Ignorance:
Some Further Observations on the Impossibility Results***

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Abstract

The paper claims that the Monotone Consistency condition utilized by Baigent in his proof of the impossibility theorem is too strong. We factorize this condition into two different weaker conditions and show that they are inconsistent with some variants of the Simple Uncertainty Aversion and the Simple Uncertainty Appeal conditions in the presence of the Independence condition.

JEL Classification: D83

Keywords: complete ignorance, uncertainty aversion, uncertainty appeal

1. Introduction

Bossert (1997) has introduced the definition of uncertainty aversion to model nonprobabilistic decision-making under complete uncertainty. The proposed definition simply states that getting an outcome x with certainty is preferred to having a set of possible outcomes that contains elements which are worse than x and better than x . He then shows that the decision rules which are characterized by the uncertainty aversion principle are closely related to the maximin rule. In Bossert, Pattanaik and Xu (2000) a weaker version of the uncertainty aversion was used to provide characterizations of some new rules for individual decision-making under complete uncertainty (see Barbera, Bossert and Pattanaik (2004) for a recent survey of results in ranking sets of objects).

On the other hand, Baigent (2004) by using a somewhat stronger version of the uncertainty aversion principle produces an impossibility rather than a characterization result. He establishes that his strengthened version of uncertainty aversion might conflict with two other conditions – Independence and Monotone consistency.

In this paper we claim that the Monotone consistency condition used by Baigent is too strong, namely it clashes with the Independence condition. We factorize Baigent's Monotone Consistency into two weaker conditions. However, even these weaker parts of the Monotone Consistency condition are inconsistent with a slightly strengthened version of the Simple Uncertainty Aversion principle and the Simple Uncertainty Appeal condition in the presence of the Independence property.

Section 2 presents the framework and the axioms. Section 3 presents the results, and section 4 concludes with some brief remarks.

2. The framework

Let X denote the non-empty and finite set of alternatives $\{x_1, x_2, \dots, x_n\}$. We assume that X contains at least three elements and it is linearly ordered from x_1 to x_n , that is, the subscript i denotes the rank of alternative x_i according to the underlying strict linear order P on X .

Let $\Pi(X)$ denote the set of all non-empty subsets of X . The elements of $\Pi(X)$ are interpreted as uncertainty prospects when the individual does not know the probability distribution nor any likelihood ranking of possible outcomes. Let \geq denote a binary relation on $\Pi(X)$ and $>$ be its asymmetric factor. $A \geq B$ means that the subset of alternatives A is at least as good as the subset of alternatives B . Notice that there are no references to the possible states of the world. What matters is only the sets of possible outcomes. Following Baigent (2004) we do not impose any particular requirements on \geq . Typically in the literature \geq is assumed to satisfy reflexivity and transitivity and quite often also completeness (see Barbera, Bossert and Pattanaik (2004) for a recent survey).

Bossert's definition of uncertainty aversion is formally captured by the following axiom.

Uncertainty Aversion (UA): For all $A, B \in \Pi(X)$ such that $A \cap B = \emptyset$, for all $y \in X \setminus (A \cup B)$, if $xPyPz$ for all $x \in A$ and all $z \in B$, then $\{y\} > A \cup B$ and $\{y\} > A \cup B \cup \{y\}$.

In Bossert, Pattanaik and Xu (2000) the following simple version of this axiom was introduced:

Simple Uncertainty Aversion (SUA): For all $x, y, z \in X$ such that $xPyPz$, $\{y\} > \{x, z\}$.

The following condition is an intermediary between UA and SUA.

*Simple Uncertainty Aversion** (*SUA**): For all $x, y, z \in X$ such that $xPyPz$, $\{y\} > \{x, z\}$ and $\{x\} > \{x, y\}$.

Clearly UA implies *SUA** which in turn implies SUA.

In Baigent's framework increases in uncertainty are identified with increases in the spread of the ranks of the alternatives in subsets. Formally, his Uncertainty Aversion axiom is formulated as follows:

*Uncertainly Aversion** (*UA**): For all $x_i \in X$, if $i = 2, \dots, n - 1$, then $\{x_i\} > \{x_{i-1}, x_{i+1}\}$, and if $i = 3, \dots, n - 2$, then $\{x_{i-1}, x_{i+1}\} > \{x_{i-2}, x_{i+2}\}$.

Further two properties are required. The first is a slight strengthening of the Independence condition introduced by Kannai and Peleg (1984).

Independence (IND): For all $A, B \in \Pi(X)$, and for all $x \in X \setminus (A \cup B)$, $A > B$ implies $A \cup \{x\} > B \cup \{x\}$.

Another property is a variant of a condition used by Arlegi (2003). Arlegi introduces the following condition, called Monotone Consistency:

Monotone Consistency (MC): For all $A, B \in \Pi(X)$, $A \geq B$ implies $A \cup B \geq B$.

MC simply says that if a set A is weakly preferred to another set B , then the worse prospect B can not be strictly better than the union of A and B . Baigent utilizes the following version of it:

*Monotone Consistency** (MC^*): For all $A, B \in \Pi(X)$, $A > B$ implies $[(A > A \cup B)$ and $(A \cup B > B)]$.

We factorize MC^* condition into the following two weaker parts:

Monotone Consistency' (MC'): For all $A, B \in \Pi(X)$, $A > B$ implies $(A \cup B > B)$.

*Dominance** (DOM^*): For all $A, B \in \Pi(X)$, $A > B$ implies $(A > A \cup B)$.

DOM^* is a variant of the Dominance condition (DOM) introduced by Kreps (1979) and utilized widely in many papers on the axiomatic ranking of opportunity sets (see Barbera, Bossert and Pattanaik (2004) for a survey of this area of research).

DOM^* simply says that if A is strictly preferred to B , then adding B to A would not reverse the preference.

Notice that MC^* also implies the following condition:

Simple Monotonicity (SM): For all $x, y \in X$ such that xPy , $x > \{x, y\} > \{y\}$.

3. The results

Baigent (2004) establishes the following result.

Proposition 1. If X contains at least five alternatives, there exists no binary relation on $\Pi(X)$ which satisfies UA^* , IND and MC^* .

However, Barbera and Pattanaik (1984) have already established that IND clashes with SM . Since MC^* implies SM as immediate consequence of Barbera and Pattanaik's result, we have the following proposition.

Proposition 2. If X contains at least three alternatives, there exists no binary relation on $\Pi(X)$ which satisfies MC^* and IND .

While MC^* clashes with IND , MC and MC' are consistent with IND even in the presence of SUA or UA^* . However, the following proposition establishes the conflict between MC' and SUA^* in the presence of IND .

Proposition 3. If X contains at least three alternatives, there exists no binary relation on $\Pi(X)$ which satisfies SUA^* , MC' and IND .

Proof. We have already assumed that for $x_1, x_2, x_3 \in X$, we have $x_1 P x_2 P x_3$. Hence using SUA^* , we have $x_2 > \{x_1, x_3\}$. MC' then implies that $\{x_1, x_2, x_3\} > \{x_1, x_3\}$. Again by SUA^* we have $\{x_1\} > \{x_1, x_2\}$. Therefore, IND implies that $\{x_1, x_3\} > \{x_1, x_2, x_3\}$ which contradicts to the fact that $\{x_1, x_2, x_3\} > \{x_1, x_3\}$. \square

Corollary. If X contains at least three alternatives, there exists no binary relation on $\Pi(X)$ which satisfies UA , MC' and IND .

We also would like to point out that DOM^* clashes with the Simple Uncertainty Appeal condition (SUP) in the presence of IND . SUP is a natural relaxation of Uncertainty Appeal condition (UP) introduced by Bossert (1997). To obtain UP condition, simply reverse the preferences in the Bossert's definition of UA .

Simple Uncertainty Appeal (SUP): For all $x, y, z \in X$ such that $x P y P z$, $\{x, z\} > \{y\}$ and $\{x, y\} > \{x\}$.

Proposition 4. If X contains at least three alternatives, there exists no binary relation on $\Pi(X)$ which satisfies SUP , DOM^* and IND .

Proof. By our assumption, we have $x_1 P x_2 P x_3$ for $x_1, x_2, x_3 \in X$. Therefore by SUP , we have $\{x_1, x_3\} > \{x_2\}$. DOM^* then implies that $\{x_1, x_3\} > \{x_1, x_2, x_3\}$. Again by SUP we have $\{x_1, x_2\} > \{x_1\}$. Hence, IND implies that $\{x_1, x_2, x_3\} > \{x_1, x_3\}$ contrary to the fact that $\{x_1, x_3\} > \{x_1, x_2, x_3\}$. \square

Corollary. If X contains at least three alternatives, there exists no binary relation on $\Pi(X)$ which satisfies UP , DOM^* and IND .

4. Concluding remarks

The paper claims that MC^* condition is too strong. It clashes with the Independence condition even without any uncertainty aversion or uncertainty appeal properties. We

factorize MC^* into two weaker conditions MC' and DOM^* . However, even the weaker Monotone Consistency condition MC' and the Dominance condition DOM^* clash with some variants of uncertainty aversion conditions, namely SUA^* and UA and some variants of uncertainty appeal conditions, SUP and UP , in the presence of the Independence condition. Hence the paper provides a first step in exploring a question of how different definitions of uncertainty aversion play role in establishing various impossibility/possibility results.

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